MOS capabilities on the 4 and 10m La Palma telescopes
(Optical Validation of Planck SZ-sources)

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   1. DOLORES/TNG MOS
   2. OSIRIS/GTC MOS
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2. Optical Validation of Planck SZ-sources (ITP13-08)
FOV=8x8 arcmin; up-to 40 slitlets
Low resolution: R~600 (1" slits) with full λ coverage
Medium Resolution  R~2000-5000
• FOV=7.5x3 arcmin (Low-R)
• Up-to 55 slitlets
• Low resolution: R~350-1000
• Medium Resolution  R~2000-2500
**MOS at 4.2m WHT**

**LIRIS** (NIR)
- FOV=3.8x3.8 arcmin
- Up to 30 slitlets
- Resolution=600-3000
- λ coverage = 1.0-2.5 µm
- Mag limit: J=19.5 (Texp=1h, R=600)

<table>
<thead>
<tr>
<th>LIRIS Grisms</th>
<th>Resolution</th>
<th>Spectral Range</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>lr_zj</td>
<td>700</td>
<td>0.887-1.531 µm</td>
<td>6.1 Å/pix</td>
</tr>
<tr>
<td>lr_hk</td>
<td>700</td>
<td>1.388-2.419 µm</td>
<td>9.7 Å/pix</td>
</tr>
<tr>
<td>mr_k</td>
<td>2500</td>
<td>K</td>
<td>low efficiency</td>
</tr>
<tr>
<td>hr_j</td>
<td>2500</td>
<td>1.170-1.356 µm</td>
<td>1.8 Å/pix</td>
</tr>
<tr>
<td>hr_h</td>
<td>2500</td>
<td>1.520-1.783 µm</td>
<td>2.6 Å/pix</td>
</tr>
<tr>
<td>hr_k</td>
<td>2500</td>
<td>2.053-2.416 µm</td>
<td>3.5 Å/pix</td>
</tr>
</tbody>
</table>

**Autofib2** (Visible, fibers)
- FOV=40x40 arcmin
- Up to 150 fibers
- Resolution = 200-4000
- λ coverage = 3800-9000 Å
- Mag limit: r=19 (Texp=1h, R=500)

Very suitable for clusters at z<0.15

**WEAVE** (Visible, fibers)
- FOV=2x2 degs
- IFU FOV =3x3 arcmin
- Up to 1000 fibers + IFU unit
- Resolution = 5000 and 20000
- λ coverage = 3800-10000 Å
- Mag limit: r=20 (Texp=1h, R=500)

The successor of AF2

Earth transmission spectrum

Palle et al. 2009 (Nat, 458, 814)
Galaxy Clusters are ideal targets for MOS at the DOLORES/TNG and OSIRIS/GTC

Texp~3000s, we obtaing spectra with:
- TNG: S/N~5 and r-mag~21
- GTC: S/N~5 and r-mag~23
- Absorption lines (K and H of Ca, G-band, Hδ and MgI) in E-type galaxies
- R~500
- Δv=100 km/s
SZ cluster identification with PLANCK

A2319 seen by PLANCK
Planck SZ cluster catalogue (PSZ1)

- Based on nominal mission data. Published in March 2013.
- New all-sky catalogue of 1227 SZ sources, the largest to date.
- Confirmed galaxy clusters: 861 (of which 178 are new).
- Candidate clusters: 366.
- Mass and redshift estimates for 813 clusters.

![Planck SZ cluster catalogue](image-url)
Optical Follow-up of Planck clusters (ITP13-8)

Optical follow-up and validation programmes (>300 candidates) in:
- Canary Islands Observatories (ITP13-8)
- ESO - Palomar - RTT

The ITP13-08 (Sep’13-Aug’15) includes:
• 22 night/telescope in the 2.5m INT, 3.6m TNG and 4.2m WHT
• 96 hours in GTC/OSIRIS

We have already observed more than 220 clusters.

- 90 Long-slit (ACAM/WHT and OSIRIS/GTC)
- 31 MOS (TNG and GTC)

z(Fe K) = 0.62
Z_{spec} = 0.660

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Multiple detections

About 5% of the Planck SZ catalogue are misidentifications or non-detections

Fossil Clusters

Galactic Gas and Dust

Maybe clusters at z>1 ???
Optical Follow-up of Planck clusters (ITP13-8)

GTC spectroscopic confirmation of a cluster at $z=0.822$ (16 cluster members have been detected using MOS/OSIRIS).
Optical Follow-up of Planck clusters (ITP13-08)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th># Members</th>
<th>Redshift</th>
<th>$\sigma_v$ (km/s)</th>
<th>$M_{\text{vir}}$ ($\times 10^{14}$ Msun)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNG/MOS</td>
<td>20</td>
<td>15-30</td>
<td>0.1-0.4</td>
<td>600-1200 km/s</td>
<td>1-30</td>
</tr>
<tr>
<td>GTC/MOS</td>
<td>3(+8)</td>
<td>15-30</td>
<td>0.4-0.85</td>
<td>600-1200 km/s</td>
<td>4-30</td>
</tr>
</tbody>
</table>

TNG/DOLORES ($z=0.106$)  
30 members  
$\sigma_v=890$ km/s  
$M_{\text{vir}}=4.5-6.5 \times 10^{14}$ Msun

OSIRIS/GTC ($z=0.822$)  
16 members  
$\sigma_v=1200$ km/s  
$M_{\text{vir}}=20-30 \times 10^{14}$ Msun
Dynamics of galaxy clusters with diffuse radio emission and X rays (The DARC project)

- Are rich clusters really virialized?
- What’s the origin of diffuse radio emission?
- How to explain X-ray enhancement
- Difference between radio halos and relics?

We develop MOS observations to sample the velocity field of clusters, identify substructures, determine masses and analyze the dynamical status of clusters.

1.- Magnetic fields are really strong in these clusters
2.- There is a huge population of relativistic electrons

What is the mecanism for accelerating electros?

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Conclusions

**DOLORES/TNG & OSIRIS/GTC at 0.1<z<0.4 & 0.3>z>0.85**

are the ideal couple to investigate Galaxy Clusters